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㉒ Display device.

㉓ A display device (1) comprises a matrix (2) of selectively settable liquid crystal cells (3) and a plurality of light sources (4, 5, 6) to produce a plurality of beams of differently coloured light. Light shutter means (7, 8, 9 or 20) provided between the matrix (2) and the light sources (4, 5, 6) include a plurality of liquid crystal portions (7, 8, 9 or 21) which are each switchable between a light-transmitting mode and a light-blocking mode. Colour selective sequential illumination of the matrix is effected by appropriate switching of the plurality of liquid crystal portions (7, 8, 9 or 21) between modes.

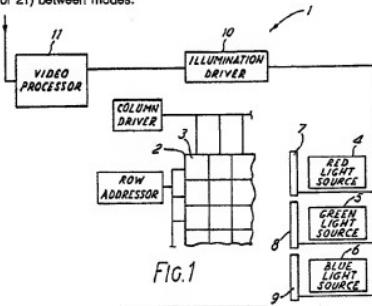


FIG.1

## DISPLAY DEVICE

The present invention relates to a liquid crystal display.

British Patent Specification No. 1433327 discloses a colour television display using three constant light sources producing red, green and blue light respectively to light a matrix of cells via a plurality of optical fibres. Associated with each source is a single liquid crystal cell whose transmission is modulated by the corresponding colour component of the video signal. The cells of the matrix are addressed sequentially and switched on and off to provide the television scan.

British Patent Specification No. 2172733A discloses a three-colour field-sequential television display in which three light sources are switched on sequentially for a third of a field period. A matrix of liquid crystal cells controlled by the video signal modulates the intensity of the light emitted by the switched light source. A problem with such a display is that it is difficult to obtain light sources with suitable switching characteristics. In one embodiment, shown in Figure 8 of that document, there is provided, however, a single non-switched light source and a rotatable multi-coloured, segmented filter.

The present invention provides a display device for the production of an image comprising a matrix of selectively settable liquid crystal cells; means to produce a plurality of beams of differently coloured light including at least one light source; light-shutter means including a plurality of liquid crystal portions for location in the light path between said at least one light source and the matrix, the liquid crystal portions being switchable between a light-transmitting mode and a light-blocking mode; and means to effect colour selective sequential illumination of the matrix by appropriate switching of said plurality of liquid crystal portions between modes.

Preferably, the display device has three light sources, each corresponding to a different primary colour, each light source having a separate associated light-shutter means.

In this way, the initiation and termination of the illumination operation is achieved by the switching of the liquid crystal portion of the light shutter, which can be effected much faster than can the energisation or de-energisation of the light source itself. The light sources can be maintained on at all times. Alternatively, they can be switched to a "power down" state when not required for illumination, thereby conserving energy; for example, the sources can be maintained, when not required, in

an energised condition where light output is low or insignificant.

In order that the invention may more readily be understood, a description is now given, by way of example only, reference being made to the accompanying drawings, in which:-

Figure 1 shows schematically part of a liquid crystal display embodying the present invention; and

Figure 2 shows another form of light shutter for use in a display embodying the present invention.

As shown in Figure 1, a display 1 has a multiplexable matrix 2 of selectively settable, i.e. operable, ferroelectric liquid crystal cells 3, the matrix 2 being back lit by red, green and blue light sources 4, 5 and 6 respectively, to produce beams of differently coloured light. In front of each light source 4, 5, 6 is placed a light valve shutter 7, 8 and 9 made of encapsulated liquid crystal material switchable between a light-transmitting mode and a light blocking mode. Colour selective sequential illumination of the matrix is effected by an illumination driver 10 controlled by a video processor 11 which switches the shutters 7, 8, 9 such that each is switched on for only one third of each frame period. The matrix 2 of cells 3 is updated at three times the normal frame rate to produce an image so that the appropriate amount of red, green and blue light is transmitted by each pixel, i.e. each cell 3, when each of the respective shutters 7, 8, 9 is switched to its light-transmitting mode to allow through light from the respective light sources 4, 5, 6.

Given a basic TV frame rate of 50 Hz, the basic frame period is 20 ms and the "light on" period for each shutter is about 7 ms. Current liquid crystal materials with a switching time of 5 ms are therefore adequate for use in the light shutters for this purpose. The light sources may be of filtered white light, or for the purposes of energy conservation, may be made in such a way as to emit light of the chosen wavelength. In the latter case the power consumption requirements of the display could be competitive with those of a conventional filtered display. Several light sources (with associated liquid crystal shutters) might be required for each colour to provide even illumination.

In an alternative embodiment, as shown in Figure 2, an extended light source switchable between the three colours to produce beams of differently coloured light could be made as follows. A light shutter 20 has a sheet of encapsulated liquid crystal material 21 made such that one side carries a

continuous transparent electrode 22 and the other a large number of small parallel electrodes 23 to 31 with a coloured filter deposited on each electrode such that the colour sequence is red, green, blue, red, green, blue and so on. Thus the portions of light shutter 20 overlying electrodes 23, 28 and 29 allow through red light when shutter 20 is appropriately driven, likewise those portions corresponding to electrodes 24, 27, 30 in relation to green light, and portions relating to electrodes 25, 28 and 31 for blue light. The light shutter 20 could be laminated to a diffusing screen, (not shown) which could also form the backplate of the ferroelectric display (not shown) and the whole back lit by an extended white light source or by a plurality of white light sources. By appropriate switching of the electrodes on the encapsulated material, a uniform, extended source of red, green or blue light could be produced. As with the embodiment of Figure 1, colour selective sequential illumination of the matrix would be effected by an illumination driver comprising of red driver 32, a green driver 33 and a blue driver 33 and controlled by a video processor (not shown) such that each of the three primary colours is transmitted for only one third of each frame period. The ferroelectric display (not shown) would comprise a matrix of liquid crystal cells which would be updated at three times the normal frame rate to produce an image so that the appropriate amount of red, green and blue light is transmitted by each pixel, i.e. cell, when the respective colour is transmitted by the light shutter 20.

In either of the examples given above the colour balance could easily be adjusted by electrically varying the degree of optical transmission of the light valve shutters in their transmissive state. In the event that the contrast ratio of the liquid crystal shutters is inadequate two or more could be used sandwiched together.

illumination of the matrix by appropriate switching of said plurality of liquid crystal portions between modes.

2. A display device according to Claim 1 wherein said means to produce a plurality of beams of differently coloured light comprises means to produce beams of light of the three primary colours.

3. A display device according to Claims 1 or 2 wherein said means to produce a plurality of beams of differently coloured light comprises a plurality of light sources each for producing a beam of a differently coloured light.

4. A display device according to any one of the preceding claims wherein a light shutter means is associated with each of a said beam of differently coloured light.

## Claims

1. A display device for the production of an image comprising a matrix of selectively settable liquid crystal cells; means to produce a plurality of beams of differently coloured light including at least one light source; light-shutter means including a plurality of liquid crystal portions for location in the light path between said at least one light source and said matrix, the liquid crystal portions being switchable between a light-transmitting mode and a light-blocking mode; and means to effect colour selective sequential

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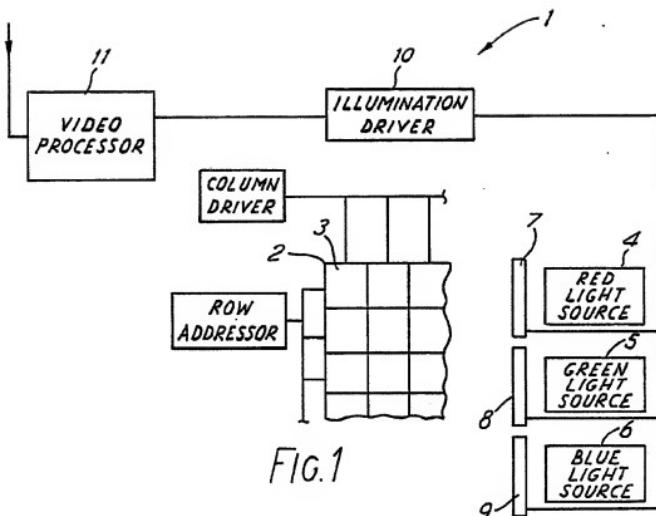


FIG. 1

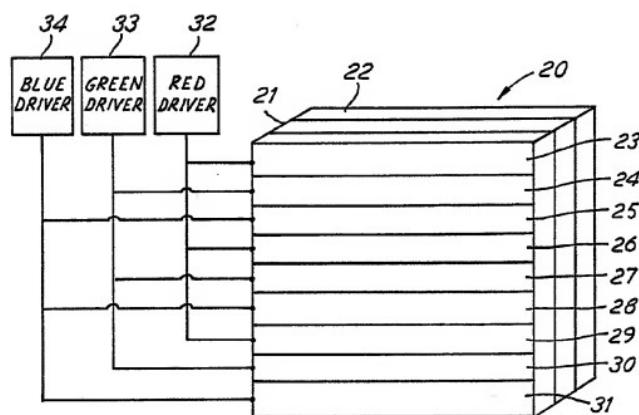


FIG. 2



European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number

EP 88 30 6147

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-3 569 614 (HANLON) * abstract; column 1, line 5 - column 2, line 16; column 2, line 71 - column 3, line 8; claims 1,2; figure 1 * ---	1,2,4	H 04 N 9/12 H 04 N 3/12 H 04 N 9/30 G 02 F 1/133
P,X	PATENT ABSTRACTS OF JAPAN volume 11, no. 319 (P-627) (2766), 17th October 1987; & JP - A - 62 106.437 (FUJITSU) 16-05-1987_(cat. X) ---	1,2,4	
D,A	GB-A-1 433 327 (AXBEY) * whole document *---	1,2,4	
D,Y	GB-A-2 172 733 (OY LOHJA) * abstract; figure 2 *---	1,2,4	
Y	WO-A-8 202 634 (KODAK) * page 1, line 2 - page 2, line 25; page 3, line 27 - page 4, line 20; page 5, lines 15-33; page 6, line 18 - page 7, line 2; page 8, line 14 - page 10, line 5; figures 1,2,4; claims 1,3 *---	1,2,4	
Y	WO-A-8 202 635 (KODAK) * page 2, line 24 - page 3, line 16; page 4, line 1 - page 7, line 33; figure 1; claims 1,2 *---	1,2,4	G 09 G 3/00 H 04 N 3/00 H 04 N 1/00 H 04 N 9/00 G 02 F 1/00
A	PATENT ABSTRACTS OF JAPAN volume 6, no. 18 (P-100) (896), 2nd February 1982; & JP - A - 56 140 319 (SUWA SEIKOSHA) 02-11-1981 ---	3,4	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
Place of search		Date of completion of the search	Examiner
BERLIN		27-10-1988	BEITNER M.J.J.B.
CATEGORY OF CITED DOCUMENTS			T : theory or principle underlying the invention E : earlier patent document, but published on, or before the date of filing of the application D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document
X : particularly relevant if taken alone Y : relevant if taken in combination with another document of the same category A : technological background O : non-written disclosure P : intermediate document			